“Slow Mapping” in Children’s Acquisition of Semantic Relations

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Are children precocious word learners?

- Does children’s word learning rest on specialized inductive processes?

- **Historical background:**
  - Modularity of language; species-specific learning

- **Empirical background:**
  - Vocabulary growth
  - Processes of word learning: “Constraints”
    - *Fast mapping*
Fast Mapping: The evidence

Carey & Bartlett (1978):
- taught 3-4-year-olds 1 color word (said 2x); used semantic contrast to disambiguate referent
  - 9 of 14 children immediately chose referent
  - 1 week comprehension: 9 of 14 chose same color (from 5 focal distractor colors)
    - same in control children

Heibeck & Markman (1987):
- 2-4-year-olds; heard 1 word twice (for color, texture or shape)
  - 10-min. 18% correct production
  - 10-min. 63% correct comprehension (4 novel items)
Is Fast Mapping a specialized word learning skill?

Deák & Gendreau: Taught 4/5-year-olds 3 or 4…

- novel words
- facts w/ novel words
- “mundane” facts
- pictorial symbols
  - Four comprehension tests; production & generalization tests
**Deák & Gendreau information types…**

<table>
<thead>
<tr>
<th>Novel Symbols</th>
<th>Novel Words</th>
<th>Facts (Mundane)</th>
<th>Facts/Novel Words</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Exp. 1)</td>
<td>(Exps. 1 &amp; 2)</td>
<td>(Exp. 2)</td>
<td>(Exp. 2)</td>
</tr>
<tr>
<td>Tama</td>
<td>“My sister gave this to me.”</td>
<td>“My tama gave this to me.”</td>
<td></td>
</tr>
<tr>
<td>Oni</td>
<td>“My friend also has this.”</td>
<td>“My oni also has this.”</td>
<td></td>
</tr>
<tr>
<td>Saybu</td>
<td>“This is from Japan.”</td>
<td>“This is from saybu.”</td>
<td></td>
</tr>
<tr>
<td>Kumo</td>
<td>“I keep this on my desk.”</td>
<td>“I keep this on my kumo.”</td>
<td></td>
</tr>
</tbody>
</table>
Test: Are one-to-one mappings easier to learn? Is this true only for novel words?

One-to-One: Words

<table>
<thead>
<tr>
<th>NW₁</th>
<th>NW₂</th>
<th>NW₃</th>
<th>NW₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₁</td>
<td>NO₂</td>
<td>NO₃</td>
<td>NO₄</td>
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One-to-One: Symbols

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Many-to-One: Words

<table>
<thead>
<tr>
<th>NW₁</th>
<th>NW₂</th>
<th>NW₃</th>
<th>NW₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO₁</td>
<td>[NO₂]</td>
<td>NO₃</td>
<td>NO₄</td>
</tr>
</tbody>
</table>

Many-to-One: Symbols

<table>
<thead>
<tr>
<th>NS₁</th>
<th>NS₂</th>
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<th>NS₄</th>
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<td>NO₁</td>
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<td>NO₄</td>
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</table>
Study 2: Rigorous test of mapping complexity: Keep # of mappings constant; compare verbal info

One-to-One: Words

\[
\begin{align*}
NW_1 & \quad NW_2 & \quad NW_3 & \quad NW_4 \\
\downarrow & \quad \downarrow & \quad \downarrow & \quad \downarrow \\
NO_1 & \quad NO_2 & \quad NO_3 & \quad NO_4
\end{align*}
\]

One-to-One: Facts

\[
\begin{align*}
NF_1 & \quad NF_2 & \quad NF_3 & \quad NF_4 \\
\downarrow & \quad \downarrow & \quad \downarrow & \quad \downarrow \\
NO_1 & \quad NO_2 & \quad NO_3 & \quad NO_4
\end{align*}
\]

Many-to-One: Words

\[
\begin{align*}
NW_1 & \quad NW_2 & \quad NW_3 \\
\downarrow & \quad \downarrow & \quad \downarrow \\
NO_1 & \quad [NO_2] & \quad NO_3 & \quad NO_4
\end{align*}
\]

Many-to-One: Facts

\[
\begin{align*}
NF_1 & \quad NF_2 & \quad NF_3 \\
\downarrow & \quad \downarrow & \quad \downarrow \\
NO_1 & \quad [NO_2] & \quad NO_3 & \quad NO_4
\end{align*}
\]
Words or pictorial symbols? Comprehension

![Bar chart showing the proportion correct comprehension for different blocks and types of stimuli.](chart.png)
Words or facts? Comprehension & production…
Findings...

- Words (object count nouns, e.g., *tama*, etc.): learned *slower* than facts or symbols (1-5 exposures)
  - In comprehension, production, & generalization measures
  - “mere presence” of a novel lexeme impedes learning

- Is the problem integrating new words with semantic networks and hierarchies?
Semantic relations & word learning:

Are semantic relations hard for children to learn? Are some easier to learn than others?
- No test of fast mapping has probed children’s inferences about semantic relations among novel words
- Markman (1989, 1994): Children tend to infer exclusivity relation between novel and known words
- Controversy: Can preschool children properly infer class inclusion relations? (Piaget: No)
  - Smith (1979): 5-year-olds make inferences about hierarchical relations
  - 3-/4-year-olds produce several labels, in semantically appropriate contexts, for a referent (Deák & Maratsos, 1998; Deák et al., 2002)
Learning new semantic relations: Studies in a controlled micro-world

- Test preschool children’s ability to infer semantic relation between new words
  - Differentiate inclusive, overlapping, and exclusive relations
    - Biological and occupational categories (of social organisms)

- “Alien” micro-world: Novel biological & occupation categories with well-defined relations
  - Are inclusion relations easier to learn than overlapping relations?
  - Are exclusion relations easiest to learn?
  - Does explicit input about semantic relations help children?
### Experiment 1 method

**Participants:** 48 children aged 4 to 7 years

**Materials:** Diorama w/ prop buildings & materials

Four categories of “alien” creatures

**Design:**

<table>
<thead>
<tr>
<th>Relations</th>
<th>Input</th>
<th>Inclusive</th>
<th>Exclusive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit</td>
<td>SB</td>
<td>BB₁ ⊙</td>
<td>BB₁ BO₂</td>
</tr>
<tr>
<td></td>
<td>SO</td>
<td>BO₁ ⊙</td>
<td>BO₁ BO₂</td>
</tr>
<tr>
<td>Implicit</td>
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<td>BO₁ ⊙</td>
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</tr>
</tbody>
</table>

- "All fegs are wuddles!"
- "A cragger can’t be an moser!"
Exp. 1 procedure…

Training session 1:
- Taught 4 words on 2 unique exemplars/word
  - Each word repeated 6x/exemplar
  - Defining features pointed out each time named
    - “This is a *feg*…because it’s green, and it has a tail”
    - “…is a *mosser*…it wears an apron & washes [these]”

Training session 2:
- Review words; 2 different exemplars/word
  - Each word repeated 9 more times

Production test:
- 5 new exemplars w/features consistent w/ 2-4 categories

Comprehension test:
  Verify category membership, for each word, of 15 new exemplars
Results: Production

$p < .002$

Number words correctly produced

4/5-year-olds  6/7-year-olds

Implicit  Explicit

$ns$
Did children produce co-extensive word pairs?

![Bar chart showing co-extensive word pairs produced by 4/5-year-olds and 6/7-year-olds. The chart indicates that 6/7-year-olds produced more co-extensive word pairs compared to 4/5-year-olds.]
Results: Comprehension

\[ p < .003 \]

Number of words understood

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Implicit</th>
<th>Explicit</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/5-year-olds</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>6/7-year-old</td>
<td>3.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

The 6/7-year-olds have a significantly higher number of words understood compared to the 4/5-year-olds, with a p-value of less than 0.003.

The difference between implicit and explicit comprehension for the 6/7-year-olds is not statistically significant (ns).
Did children represent correct relation between word pairs (comprehension)?

(\textit{most of these are correct exclusion relations})

- 4/5-year-olds
- 6/7-year-olds

<table>
<thead>
<tr>
<th>Relation</th>
<th>4/5-year-olds</th>
<th>6/7-year-olds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species-Species</td>
<td>0.40</td>
<td>0.60</td>
</tr>
<tr>
<td>Occ-Occ</td>
<td>0.10</td>
<td>0.50</td>
</tr>
<tr>
<td>Species-Occ</td>
<td>0.10</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Conclusions: Experiment 1

- Older children understood and produced 2-3 words after 21 exposures (ostension + definition)
  - 4/5-year-olds typically learned 1 of 4 words

- Learning semantic relations between words:
  - Explicit input about semantic relation did not help
  - 4/5-year-olds seldom produced 2 or more words for a referent, despite prompts
  - 4/5-year-olds often inferred exclusion relation between species and occupation words (Markman, 1991)
  - 6- and 7-year-olds learned more semantic relations

- Ruling out inattention: $n = 8$ randomly chosen children looked at exemplar or experimenter’s face in $M = 95\%$ naming episodes.
Experiment 2: Replication

Modifications:
- Changed some features to make categories more distinctive & memorable
- Added training exemplars to clarify that multiple species could have any occupation
- Scenarios/stories added to make training more play-like; Prompted & reinforced children for naming exemplars

Participants:
- $n = 24$ 4/5-year-olds
- $n = 24$ 6/7-year-olds
Experiment 2 results: Production

Number words correctly produced

4/5-year-olds 6/7-year-olds

Implicit Explicit

$p < .001$

$ns$
Co-extension of words? (Experiment 2)

<table>
<thead>
<tr>
<th>Overlap relation (N = 48)</th>
<th>No Spec-Occ overlap</th>
<th>Allow Spec-Occ overlap</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/5-year-olds</td>
<td>16</td>
<td>8</td>
</tr>
<tr>
<td>6/7-year-olds</td>
<td>6</td>
<td>18</td>
</tr>
</tbody>
</table>

\[ \chi^2 (df = 1) = 8.4, \quad p < .005 \]

<table>
<thead>
<tr>
<th>Inclusion relation (N = 24)</th>
<th>No inclusion</th>
<th>Allow inclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>4/5-year-olds</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>6/7-year-olds</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>
Conclusions for now

What is general about word learning? (Deák, 2000)
- Sensitive to frequency and correlation, delay, cognitive load, cue validity, perceptual ‘set’, priming, discrimination/contrast
- Motives to: affiliate; predict/influence others’ behavior; play; learn

What is unique about the lexicon-learner relation?
- Must acquire fast access to large set w/ complex systems of associations & relations (e.g., phonology, morphology, syntax
- Flexible uses & senses: metaphor; polysemy/polynomy

Does this rest on dedicated learning mechanisms?
- Words are not learned more easily than, e.g., facts or figures
- Non-lexical patterns of input can draw infants’ attention to categories, objects, etc.
Conclusions continued

4/5-year-olds do not learn a small lexical-semantic system, even after 20+ repetitions (ostension & definition)

Most children misconstrue semantic relations among new words
  - Exclusion relations are most readily inferred (Markman, 1994)

Conundrum: If children have such trouble, how do they learn correct relations between real words? (Deák & Maratsos, 1998)
  - cognitive load might have limited inductive processing or memory

Future questions:
  - How do cognitive load, learning context, input (e.g., definitions), & word kinds interact with processes of learning semantic relations?
  - “What develops?”: Why do 6/7-year-olds do better?
Thanks to…

- National Academy of Education and Spencer Foundation for material support
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